A Comprehensive Review of Pediatric Urachal Anomalies and Predictive Analysis for Adult Urachal Adenocarcinoma

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Abbreviations and Acronyms

CER = control event rate

CT = computerized tomography

EER = experimental event rate

MRI = magnetic resonance imaging

NNT = number needed to treat

VCUG = voiding cystourethrography

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Purpose: We examined the presentation, diagnosis and management of radiologically detected pediatric urachal anomalies and assessed the risk of malignant degeneration.

Materials and Methods: Our radiology database (2000 to 2012) was queried for all children younger than 18 years who were diagnosed with a urachal anomaly radiographically, and the operative database was used to determine those who underwent excision. Data collected included demographics, presenting symptoms, imaging modality and indication for excision. These data were compared to the Ontario Cancer Registry to determine the risk of malignancy.

Results: A total of 721 patients were radiographically diagnosed with a urachal anomaly (667 incidentally), yielding a prevalence of 1.03% of the general pediatric population. Diagnoses were urachal remnants (89% of cases), urachal cysts (9%) and patent urachus (1.5%). Ultrasonography was the most common imaging modality (92% of cases), followed by fluoroscopy/voiding cystourethrography (5%) and computerized tomography/magnetic resonance imaging (3%). A total of 61 patients (8.3%) underwent surgical excision. Indications for imaging and treatment were umbilical drainage (43% of patients), abdominal pain (28%), palpable mass (25%) and urinary tract infection (7%). Mean age at excision was 5.6 years and 64% of the patients were male. Based on provincial data, the number needed to be excised to prevent a single case of urachal adenocarcinoma was 5,721.

Conclusions: Urachal anomalies are more common than previously reported. Children with asymptomatic lesions do not appear to benefit from prophylactic excision, as the risk of malignancy later in life is remote and a large number of urachal anomalies would need to be removed to prevent a single case of urachal adenocarcinoma.

Key Words: pediatrics, urachal adenocarcinoma, urachus

Symptomatic urachal anomalies in children have traditionally been removed to alleviate the symptoms. However, the recent literature suggests excision of even incidentally discovered urachal anomalies to prevent future problems.[1] The most serious issue encountered is development of urachal adenocarcinoma, which, although extremely rare, carries significant morbidity and mortality. The literature is inconclusive on how to manage pediatric urachal lesions, especially those discovered incidentally. Removal of asymptomatic urachal remnants is often recommended systematically after diagnosis to prevent future issues or if present on repeat imaging

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after age 6 months.[2] Others advocate removing only lesions that present with symptoms. Still others advocate nonoperative management as a reasonable approach in asymptomatic and a subset of symptomatic lesions, including those presenting as infected cysts.[3] Divergent views on management clearly highlight a lack of consensus and an ill defined therapeutic or prophylactic value of surgical resection.

The true incidence of urachal anomalies in children is unknown, as is the risk of future malignant degeneration. Given the rarity of both conditions, we postulated that the preventive value of systematic resection of asymptomatic lesions detected in childhood is minimal and the procedure is likely unwarranted. We examined the prevalence, presentation, diagnosis and management of radiologically identified pediatric urachal anomalies at a large tertiary pediatric center, correlating the results with previous publications dealing with urachal neoplasms in the same geographic region to assess the likelihood of a urachal anomaly degenerating into a malignancy later in life.[4]

MATERIALS AND METHODS

Our institution principally serves the province of Ontario, a geographic region roughly the size of western Europe, containing a population of approximately 10 million. After receiving approval from our institutional research and ethics board we retrospectively queried the electronic radiology database of our regional referral center for all children younger than 18 years examined between January 2000 and December 2012 undergoing abdominal evaluation via 4 distinct modalities, ie ultrasound, fluoroscopy/VCUG, CT and MRI. Imaging type was the denominator in the calculation of the prevalence of urachal anomalies. We then parsed radiology reports for "urachus" or "urachal." The charts of those patients were then individually reviewed to confirm the diagnosis, excluding those in whom "urachus" or "urachal" was not associated with an identified urachal lesion. Type of study used to diagnose the urachal anomaly, radiographic findings, and patient age and gender were noted. The resulting filtered list was also cross-referenced to any operative procedures performed in the same time range to identify patients who underwent surgical intervention for the identified urachal lesion. Patient demographics, presentation and histopathological data were collected, as well as indication for intervention.

Results were cross-referenced with previously published data from the Ontario Cancer Registry on the yearly incidence of urachal adenocarcinoma in the same geographic catchment area (0.18 of 100,000 individuals yearly)[4] to estimate NNT to prevent a single case of urachal adenocarcinoma, where "treat" is defined as surgical excision. This calculation was based on the assumptions that 1) all urachal adenocarcinomas develop in patients with urachal anomalies, 2) urachal excision in childhood eliminates the risk of subsequent urachal adenocarcinoma and 3) urachal anomalies do not spontaneously involute or lose malignant potential if not removed. The calculation sequence for estimating NNT to prevent a single case of adenocarcinoma is, absolute risk = annual incidence of urachal adenocarcinoma in the general population = 0.18/100,000; CER = annual incidence of urachal adenocarcinoma in those with urachal anomalies; EER = annual incidence of urachal adenocarcinoma in patients following surgical excision of the urachal anomaly (therefore = 0); RRR = CER/(CER - EER) = incidence reduction in event rate following intervention, ie excision of urachal lesion (therefore = 1); absolute risk reduction = CER - EER = CER, and NNT = 1/absolute risk reduction.

RESULTS

During the 13-year period 64,803 patients underwent at least 1 abdominal imaging study at our institution. Of those patients 721 were radiographically diagnosed with a urachal anomaly (667 incidentally). Mean age at diagnosis was 6.2 years (interquartile range 1.7–9.4). Radiological data are summarized in the table. Specific imaging diagnoses were persistent urachal remnants, urachal cysts, sinus tract/patent urachus and urachal diverticulum. Ultrasonography was the most commonly used imaging modality, followed by fluoroscopy/VCUG, CT and MRI. Figure 1 illustrates a urachal remnant on ultrasound and a large urachal cyst on CT. Figure 2 illustrates the large urachal cyst intraoperatively.

Of the study population only 60 patients (8.3%) underwent surgical excision. Six cases (10%) were excised laparoscopically and 54 (90%) in an open manner. Indications for imaging and treatment in the surgical group were umbilical drainage in 26 patients (43%), abdominal pain in 17 (28%), palpable mass in 15 (25%) and urinary tract infection in 4 (7%). However, 6 of the cases excised (10%) were incidentally diagnosed, and prophylactic excision was undertaken because of recent recommendations made in the literature, as noted in the medical charts. Mean age at excision was 5.6 years (range 3 days to 17.1 years) and 64% of patients were male. No complications were reported in those undergoing simple excision, and all symptomatic patients were cured of the presenting symptoms.

Summary of radiological data

No. imaging diagnosis (%):	
Urachal remnant	640 (89)
Urachal cyst	66 (9)
Sinus tract/patent urachus	11 (1.5)
Urachal diverticulum	4 (0.6)
No. imaging modality (%):	
Ultrasound	665 (92)
VCUG/fluoroscopy	38 (5)
CT	13 (2)
MRI	5 (0.7)

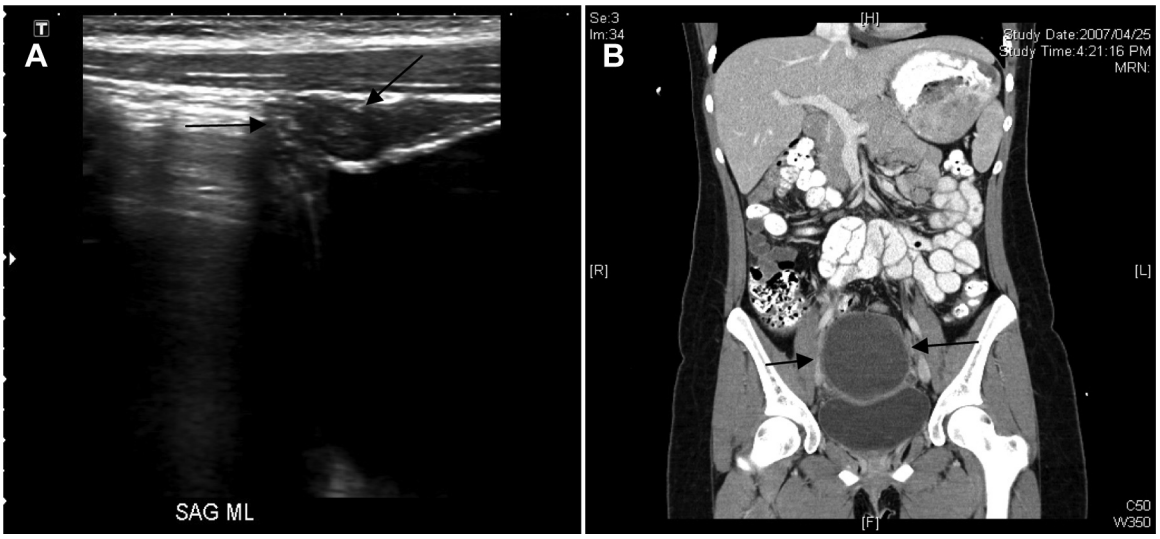


Figure 1. *A,* ultrasound shows urachal remnant (arrows). *B,* CT reveals large urachal cyst (arrows).

Review of the histopathology reports confirmed that the majority of the specimens (72%) contained epithelial elements, with urothelium present in 29 (bladder cuff tissue excluded, 43%), followed by intestinal epithelium in 11 (18%) and various other types of epithelia in 6 (10%, fig. 3).

The overall number of urachal anomalies diagnosed incidentally was 667, yielding a prevalence of 1.03% (assuming that all urachal remnants are detected by these studies and all reports systematically list such findings). Based on these figures and the formula outlined, the estimate for NNT to prevent a single case of adenocarcinoma is 5,721.

DISCUSSION

Urachal anomalies in children are relatively uncommon, found incidentally in approximately 1% of those undergoing imaging in this single institutional cohort. Ultrasonography is by far the most commonly used imaging modality in diagnosis, and most anomalies are asymptomatic urachal remnants. Of those excised histopathology confirmed that the majority (72%) contained epithelial components, which have been postulated as a risk factor for adenocarcinoma later in life. No complications were seen in the surgical group, yielding a relatively small degree of morbidity that was associated with the excision itself.

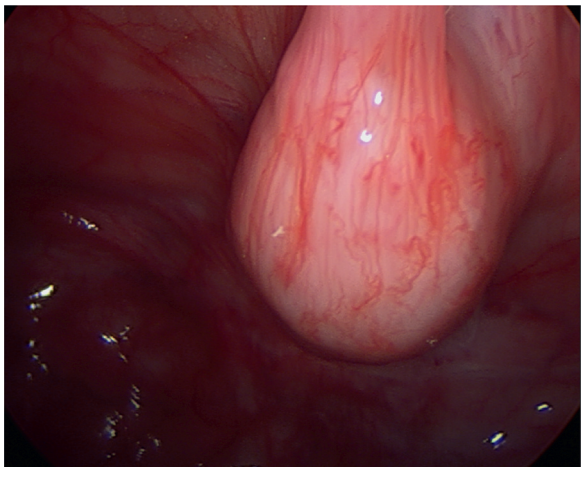
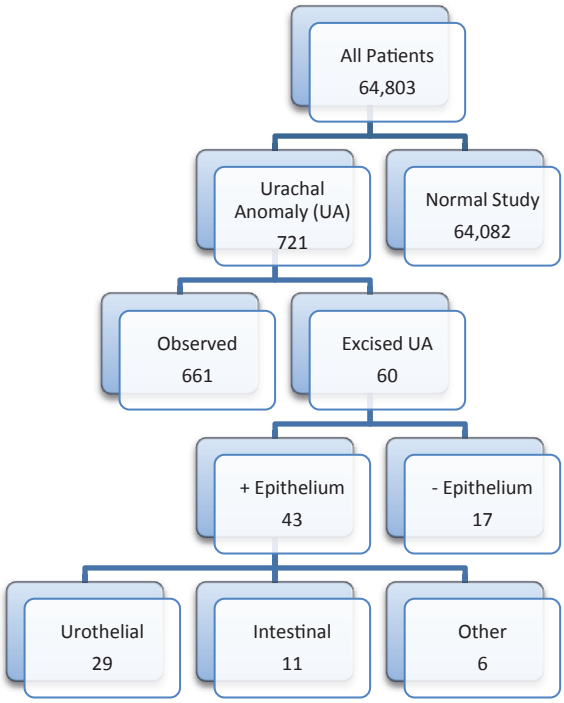


Figure 2. Laparoscopic view of large urachal cyst

Urachal anomalies are thought to be associated with an increased risk of bladder adenocarcinoma in adults, and urachal adenocarcinoma has an estimated incidence of 0.18 per 100,000 individuals yearly.[4] These cases account for 0.1% to 0.3% of all bladder malignancies and 20% to 39% of bladder adenocarcinomas.[5]

To calculate NNT, a few general assumptions were made about the natural history and course of these findings. The first assumption was that urachal adenocarcinoma only develops in those with urachal anomalies. The natural history of asymptomatic urachal anomalies is unknown. However, a study from the Mayo Clinic postulated that urachal lesions can provide a source of chronic infection/inflammation, often associated with a carcinogenic state if left untreated.[1] Without any urachal tissue it seems unlikely that a urachal tumor could develop. The next assumption is that excision of all urachal tissue eliminates the risk of urachal tumor, which follows the same reasoning. Another assumption is that urachal lesions do not involute, and those identified in this study would persist indefinitely. This notion is arguable, as a previous study suggested that many urachal remnants will



Indications for Excision	n (%)
Umbilical Drainage	26 (43)
Abdominal Pain	17 (28)
Palpable Mass	15 (25)
Urinary Infection	4 (7)
Prophylactic	6 (10)

Figure 3. Flow chart of study subjects and indications for excision

resolve by age 6 months and they should be considered physiological in this age group.[2] With that in mind, the majority of remnants discovered in our study were in much older children (mean age 6.2 years) and only 13.8% were found initially in children younger than 6 months (data not shown).

Compared to similar large institutions, the prevalence of urachal anomalies in children at our institution is much higher than in previous reports.[2,3,6] While it is possible that this finding is a result of more sensitive radiological case reporting of these lesions in the bladder dome compared to other institutions, it suggests that these anomalies are not as rare as previously thought. Furthermore, more sensitive radiological detection in general would ultimately lead to an even greater NNT.

A small minority of these lesions (8.3%) were excised during the study period. Despite the majority of these lesions being labeled as normal variants, the incidence of urachal malignancy in the same geographic region remains extremely low (0.18 per 100,000 individuals yearly), although considerably more time would be needed to follow our patient sample into adulthood. While there have been reports advocating nonoperative management of even symptomatic lesions,[3] treatment of this population has been observed to be safe and efficacious. The present study confirms this finding, as no surgical complications were seen in our patients and all were cured of the presenting symptoms.

Multiple studies recommend removing even asymptomatic urachal remnants to prevent the risk of urachal adenocarcinoma in adulthood. The calculated NNT in our study is 5,721. Prophylactic surgical excision is clearly neither feasible for such a large NNT nor reasonable, given the benign pathological findings. Compare this condition to a much more common malignancy such as breast cancer. Indeed, the American and Canadian Cancer Societies estimate that breast cancer will develop in approximately 10% to 12% of women and that it will be responsible for the deaths of 3% of all women.[7,8] According to American Cancer Society statistics, the number of prophylactic mastectomies required (NNT) to prevent a single case of invasive breast cancer is 8,[7] which is much smaller than the NNT of 5,721 estimated in our study. Nevertheless, without specific and well-known additional risk factors (eg, well recognized breast cancer mutations), no agency is recommending prophylactic mastectomy for the general female population. The same argument could be extended to other malignancies seen in the urological population (penile, testis, etc).

The evolution in the management of urachal lesions could be compared to that for multicystic dysplastic kidney. Many multicystic dysplastic kidneys were previously removed in the belief that Wilms tumor was being prevented. More recent literature would refute that,[9] and we now know that this finding necessitates much less than

previously thought in terms of followup, imaging and intervention.

Of urachal malignancies removed in adults 94% are carcinomas,[10] suggesting that an epithelial component is necessary in the malignancy development process in the majority of these cases. By comparison, histopathological analysis of excised lesions in a small series of children (29 patients) was reported as revealing an epithelial component in only 69% of lesions.[11] Our larger series confirms that most but not all urachal anomalies (72%) contain epithelium, potentially decreasing the likelihood of degeneration into carcinoma. Assuming that epithelium is required in the development of urachal adenocarcinoma, the extrapolated NNT would be more than 8,000, as nearly 30% of urachal anomalies are void of an epithelial component.

Limitations of this study include the retrospective nature and potential for missed data, which could change the prevalence of urachal anomalies. Ideally a random subset of the entire population would be screened. As this is not possible, patients presenting to our institution with other unrelated complaints for abdominal imaging were deemed an acceptable alternative. Additionally it has been demonstrated that some of these lesions will involute and resolve with time,[2] and this is certainly also the case with this cohort. However, the mean age in the current study is much older than the age suggested to allow for spontaneous resolution of these lesions. Also urachal adenocarcinoma could theoretically develop in anyone with urachal tissue. The purpose of this study was not to suggest that only those with anomalies are at risk, but rather to challenge the notion that urachal anomalies confer an increased risk significant enough to warrant excision in the asymptomatic patient.

Finally, as our institution draws from the same geographic region as the Ontario Cancer Registry, we assume that our cohort is representative of the same population. Long-term followup of this cohort could help to answer more questions about the natural history of observed urachal anomalies, although this would take decades to accomplish.

CONCLUSIONS

Urachal anomalies appear to be much more common than previously reported, with a prevalence of approximately 1%. Excision of symptomatic urachal anomalies is an effective and safe means of treatment, with minimal morbidity. However, most patients with simple and asymptomatic lesions do not appear to benefit from excision, as the risk of malignancy later in life is vanishingly remote. Nevertheless, each child should be treated individually, and large or otherwise suspicious lesions may warrant excision. However, based on our current data, a large number of urachal anomalies would need to be removed to prevent a single case of adenocarcinoma of the urachus.

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